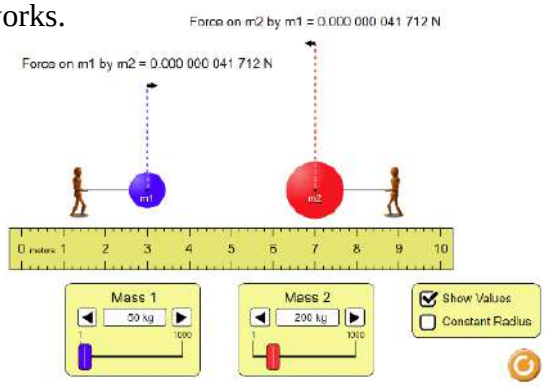
Name_____ period ____

The Weakest Force lab # _____

Today you will use a PhET to study how the force of gravity works.



→ Everyone must **use their own numbers** and **do their own work**.

Do a Google search with "Gravity PhET."

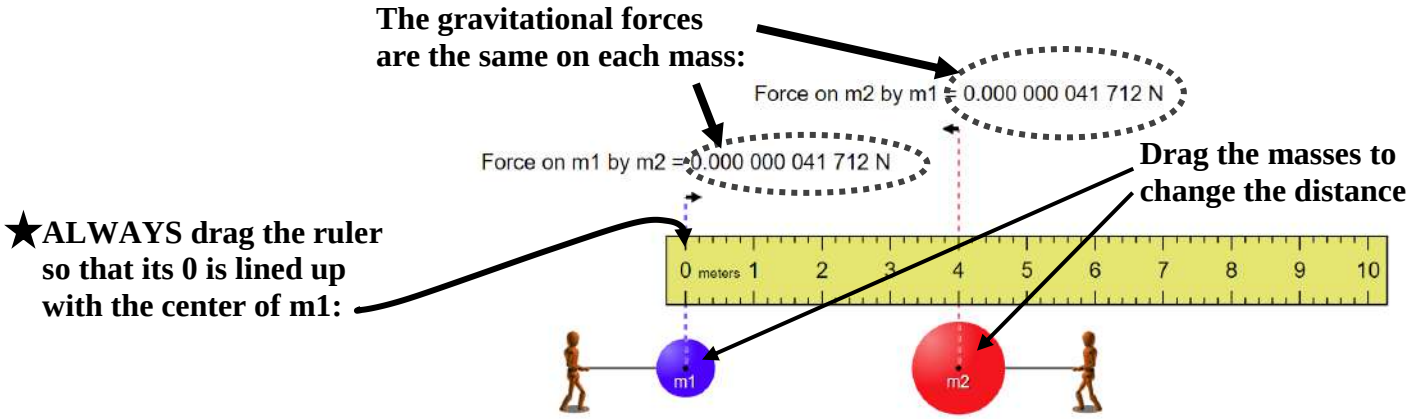
Follow the link to the *Gravity Force Lab*.

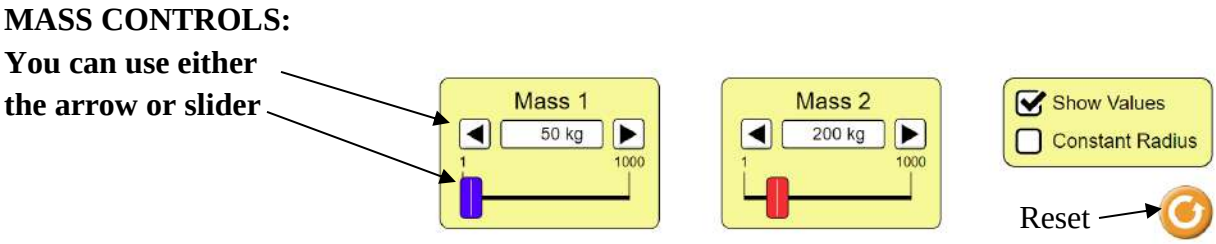
Press the play arrow ▶ in the center of the image.

You will see something like…

I. The Controls.

Important: All the forces shown are very small. To avoid tiny numbers, we assume that all numbers that you record are "x 10^{-12} N." So when you see a number: 0.000 000 003 **960**, record it as **3960**.





II. Mass

1. To measure the distance easily, drag the ruler so that its 0 is lined up with the *center* of m1.
   Drag m2 away from m1 so that the *center* of m2 is at any distance **greater than 3 m from m1.**
   Do NOT change this distance d for this entire section.
   Record the distance between centers: d = _____ m
2. Choose m1 and m2 to be anywhere in the range from 5 to 200 kg.
   Use different masses than what your neighbor uses.
   Record initial masses here: m1 = _____ kg m2 = _____ kg
3. Record the initial force $\mathbf{F_0}$ = _____ (x 10^{-12} N). *Remember!* Write "0.000 000 003 960" as "3960"
4. Double m2 to get a **new m2**. Record the result in table on the next page.
   Enter your new m2 value into Mass 2 control. Record the new force in table in the $\mathbf{F_{new}}$ column.
5. In the last column, divide the $\mathbf{F_{new}}$ by the $\mathbf{F_0}$ you wrote in Step 3 above.
6. Then triple the *original* m2 (in Step 2 above). Repeat steps to fill out table.

change in original m2	new m2 (kg)	F_{new} (x 10^{-12} N)	F_{new}/F_0 Round to whole #
2x			
3x			
4x			
5x			

Q1. What is the relationship (*linear, quadratic, inverse, inverse squared*) between $\mathbf{F_{new}/F_0}$ and $\mathbf{m_2}$?

Q2. Sketch the graph: $\mathbf{F_{net}/F_0}$ vs m2

III. Distance

1. Move the masses so that their **centers** are a distance d = 1.0 m apart. You may have to decrease the mass.
   → Do NOT check the *Constant Radius* box.
   → ***Don't change the masses for this entire section.***
   → **The force must be ≥ "1000"** to start.
2. Use different masses than what your neighbor uses. Do NOT copy or you will not get credit.
   Record here: m1 = _____ kg m2 =_____ kg
3. Record the initial force $\mathbf{F_0}$ **=** _____ (x 10^{-12} N).
   This is $\mathbf{F_{new}}$ for d = 1.0 m in the table at right.
4. Increase d to get the data for each row in the table.
   Record each new force in the $\mathbf{F_{new}}$ column.
5. Divide each $\mathbf{F_{new}}$ by the $\mathbf{F_0}$ you recorded in Step 3.
   Record your result in the last column.
   Round it to 2 significant digits.

d (m)	F_{new} (x 10^{-12} N)	F_{new}/F_0 (2 sig. figs.)
1.0		1.00
2.0		
3.0		
4.0		
5.0		

6. You are done using the PhET. Return your Chromebook. Don't forget to plug it in.

Q3. Work with the table at right.
A) Convert the fractions in the first and third columns to decimal notation (3 sig. figs).

B) Look at the columns 1/d and $1/d^2$. Which of these 2 columns is closer to the F_{new}/F_0 column of the table above?

1/d (fraction)	1/d (decimal)	$1/d^2$ (fraction)	$1/d^2$ (decimal)
1	1.00	1	1.00
1/2	0.500	$1/(2^2) = 1/4$	0.250
1/3		$1/(3^2) = 1/9$	
1/4		$1/(4^2) = 1/16$	
1/5		$1/(5^2) = 1/25$	

Q4. Both questions A) and B) have 2 answers: one in **bold** and another in *italics*:
A) When d was doubled (1 to 2), was the new gravitational force **2x or 4x** *stronger or weaker*?
B) When d was tripled (1 to 3), was the new gravitational force **3x or 9x** *stronger or weaker*?

Q5. A) What is the relationship (*linear, quadratic, inverse, inverse squared*) between $\mathbf{F_{new}/F_0}$ and d?

B) Sketch the graph: $\mathbf{F_{new}/F_0}$ vs d